PHY 491 - QUIZ 7

November 4, 211

For a 2-d tight binding model for electrons moving on a square lattice

(i) What is the **k** (k_x,k_y) dependence of energy in terms of the intrasite (α) and nn hopping matrix elements (γ)?

$$\varepsilon_{\vec{k}} = \varepsilon(k_x, k_y) = -\alpha - 2\gamma(cosk_x a + cosk_y a)$$

(ii) What are the range of k_x and k_y values?

$$-\frac{\pi}{a} \leq k_x \leq \frac{\pi}{a}; -\frac{\pi}{a} \leq k_y \leq \frac{\pi}{a}; 1st\ Brillouin\ Zone\ (BZ)$$

(iii) Where in the 1st Brillouin Zone are the energy band maxima?

$$(k_x, k_y) = \left(\mp\frac{\pi}{a}, \mp\frac{\pi}{a}\right);$$

$$4\ corners\ of\ the\ square\ BZ$$

(iv) What is the effective mass of electrons with **k** vector near the above band maxima?

$$\varepsilon(k_x, k_y) = \varepsilon\left(\frac{\pi}{a}, \frac{\pi}{a}\right) + \frac{\hbar^2}{2m^*}\left(K_x^2 + K_y^2\right)$$

$$\varepsilon\left(\frac{\pi}{a}, \frac{\pi}{a}\right) = -\alpha + 4\gamma$$

$$m^* = -\frac{\hbar^2}{2\gamma a^2}$$